Description

Method, system and apparatus for managing connections in a telecommunications network

The invention relates to network management to plan and run optimized telecommunication and data networks and, more particularly, to the administration of signaling and bearer connections between adjacent network elements.

Modern telecommunications networks generally include two separate communication pathways. The first is a voice network that handles the transmission of voice or other information between users via so-called bearer channels or bearer connections. These connections are sometimes specifically referred to as TDM (Time Division Multiplexing) bearer connections. The second is a signaling network that facilitates the dynamic linking of a plurality of voice network circuits, such that a bearer or voice-type connection is established between a calling party and a called party. Additionally, the signaling network provides a framework through which non-voice related information may be transported in a manner that is transparent to the user. This signaling technique is often referred to as "out of band" signaling, where the term "band" implies voice band. Common examples of such out of band data transport are the access of 800 number database services, calling card verification services and caller ID services.

In order to provide consistent and reliable communication across the signaling network infrastructure, a common or standard digital signaling protocol known as Signaling System 7 (SS7) has been developed. SS7 is an out of band common channel signaling system that uses labeled messages to transport circuit related signaling information, non-circuit related signaling information, network resident database service information and other information that may be used for the establishment of communication services. From a hardware

perspective, an SS7 network includes a plurality of SS7 network elements or nodes, generically referred to as Signaling Points (SP), that are interconnected using signaling links, also referred to as SS7 links.

In such a telecommunications network it has been found convenient to have centralized management of the network elements. However, the prior centralized management systems had failed to provide a suitable means by which the network resources can be configured. In particular, applications for network management in a Public Switched Telephone Network (PSTN) and Next Generation Converged Networks (NGN), it would be highly desirable to provide efficient configuration of the network resources.

Typically, these applications are defined as specific data and object models, in part, in the Q.751 Series of the ITU recommendations. One of the main problems is that during, for example, creation, deletion and modification of objects, several prerequisites and dependencies between these objects have to be detected, considered and resolved. Problematically, the managed objects must be administered in the right sequence and/or with identical parameter values at both ends of the bearer or signaling connections.

In particular, this applies to the administration of directly connected (or adjacent) network elements. Nearly identical data must be provided for signaling or bearer connections in the two network elements providing for both ends of a connection. If the signaling link sets and/or links, that form the signaling connection of two adjacent network elements, or the bearer trunk groups and/or trunks, that form the bearer connection of two adjacent network elements, are independently managed, then wrong input leads to implausible routing data and, hence, routing errors.

In a typical situation, the operator works with single configuration commands, for instance, via command line interfaces of a network element, by usually administering only one managed object in one network element at a time. Therefore, the operator must memorize a number of prerequisites and dependencies and a failure to do so leads to rejected configuration commands or, worse, to unrejected commands that cause implausible routing data to be entered into the network elements.

In addition, the previous attempts at network management were limited to configuring a single network element at a time. Further, network re-configurations or ad-hoc or short term changes were not possible using the previous method.

It is, therefore, an object of the present invention to provide a method for managing connection objects such as signaling connections or bearer connections.

It is another object of the present invention to provide a method for managing connection objects automatically.

It is another object of the present invention to provide a method for managing connection objects that automatically transposes from the administration of one network element the configuration data for another network element.

It is another object of the present invention to provide a method for managing connection objects that automatically determines an adjacent network element.

It is another object of the present invention to provide a system for managing connections objects.

In accordance with the foregoing objectives, there is provided by the invention at least a method for managing connection objects in a telecommunications network having network

elements including a first network element and a plurality of other network elements. Among the plurality of the other network elements there is determined a second network element adjacent to the first based on an operator input. The data associated with the first network element is then automatically transposed for the second network element such that the representation of a connection object between the first and second network elements is made commensurate to the representation for the first network element.

An advantage thereof is that the connection object is managed for the network elements without the risk of wrong input which would prevent implausible routing data to be entered.

In one aspect of the invention, the data to be transposed can be obtained from a history of commands associated with administering the connection object and/or a database stored in any of the network elements.

In case of absence of objects prerequisite to managing the signaling connection, according to the invention, there is further provided the creation of the prerequisite objects for the second network element. An advantage therefore is that the operator need not verify the presence of the prerequisites in the second network element.

In another aspect, the invention provides detecting a link set (a trunk group) terminating at the first network element by querying for the second network element all objects representing link sets (trunk groups). In case no link set (trunk group) for the second network element that terminates at the first network element is detected, the invention creates a new link set (trunk group) for the second network element by making the link set (trunk group) of the second network element commensurate to the link set (trunk group) of the first network element. In addition the present invention is capable of the following network management tasks: deleting a link

and/or a link set (a trunk or a trunk group), modifying a link and/or a link set (a trunk or a trunk group), performing a status change of a link and/or a link set (a trunk or a trunk group) and creating a link and/or a link set (a trunk or a trunk group) according to a respective management operation at the first network element.

The present invention is further providing a method for detecting the adjacent network element by extracting a first point code and a first sub-network identifier that identifies first network element and, in addition, a parameter indicating an adjacent network element. The invention compares the parameter and the first sub-network identifier to a point code and a sub-network identifier of a respective network element from at least a subset of the other network elements. An advantage therefore is that the operator does not have to specify the adjacent network element, which, in a network of a plurality of sub-networks may be difficult for an operator to detect.

The present invention is also directed to managing connection objects in a telecommunications network that supports a Signaling System 7 (SS7) standard.

The invention is further directed to providing a task group that is transparent to an operator for grouping objects for managing the connection objects associated with the first network element and dependent objects for managing the connection objects associated with the second network element. An advantage therefore is that the operation is transparent to the operator.

The invention is further a computer-readable product having recorded thereon computer instructions for instructing a computer to execute the novel invention.

The invention also has within its scope a system for managing connection objects in a telecommunications network that includes a plurality of network elements and a control module for configuring at least a first network element in accordance with an operator input. A control program may determine an origination within the first network element associated with the connection object to be managed and further determines a second network element that is adjacent to the first network element and causes a representation of the connection object of the first network element to be transposed for the second network element such that a corresponding connection object for the second network element is made commensurate to the representation for the first network element.

Similar to the method of the invention, the system advantageously assists an operator in managing network resources.

The system of the invention further has the capability to detect a link set (trunk group) terminating at the first network element by querying for the second network element all objects representing link sets (trunk groups).

The invention further provides for the determination of a link set and links (trunk group and trunks) of the second network element terminating in the first network element by at least determining that the first and second network elements are in a same sub-network.

The system of the invention further provides a task group that is transparent to an operator for grouping objects associated with the first network element and dependent objects for managing the connection objects associated with the second network element.

In the following, of the invention will be described in more detail in the form preferred embodiments which are better understood in accordance with the following figures.

Figure 1 is a flow diagram of the present invention for managing signaling connections;
Figure 2 is a diagram of a network configuration comprising signaling connections;
Figures 3 a-d are a flow diagram of the present invention for managing signaling connections;
Figure 4 is a system diagram of the present invention for managing signaling connections;
Figure 5 is a flow diagram of the present invention for managing bearer connections;
Figure 6 is a diagram of a network configuration comprising bearer connections;
Figures 7 a-d are a flow diagram of the present invention for managing bearer connections;
Figure 8 is a system diagram of the present invention for managing bearer connections.

Managing Signaling Connections (Figs. 1 through 4)

A first general embodiment of the invention will now be described wherein the managed connection objects are signaling connections. Figure 1 shows in general form the flow diagram 100 of the first general embodiment of the present invention. In step 102, an operator input is made to a first network element, which is denoted by a network element A. In a preferred aspect of the invention, the operator input includes the point code of network element A, the network or sub-network name, and a desired signaling link set that is to be managed. With the operator input, the invention extracts the network or sub-network name, identified by, for example, a network indicator. In addition, the invention may extract an identifier indicating the address of the network element A by using, for example, a point code of the network element A. Further, there may be extracted an adjacent point code, which indicates the targeted network element that is to be managed

in commensuration with the data representative of the signaling connection for network element A.

In step 104, the invention detects the adjacent network element. This may, for example, be accomplished by accessing data of available network elements and, in each network element, determining the network indicator and the own point code for the respective network element. In steps 106 and 108, the invention may detect elements belonging to the same network or sub-network and, upon detecting network elements within the same network or sub-network, continues in steps 110 and 112. Among the detected network elements in the same network or sub-network, the method then detects the adjacent network element by matching information, such as, the adjacent point code detected in step 102.

The invention now detects in steps 114 and 116 the link set to be managed, e.g., in the adjacent network element. More specifically, and according one possible aspect of invention, the link sets of the detected network element are searched for the link set to which network element A is the adjacent network element.

After determining the correct network or sub-network and, within that, the adjacent network element, and for the adjacent network element the appropriate link set, the invention now has all the prerequisites to manage the signaling connection. Part of managing signaling connection may, for instance, be creation of an appropriate link set if no such link set was identified (steps 120 and 122). In more detail, the invention creates the link set for the adjacent network element to be commensurate with the attributes from the link set of the network element A. The step of managing may further comprise steps 126 to 130, in general, for detecting an object to be managed and managing the object, such as, creating link sets and/or links, deleting, modifying, activating and/or changing the status of links and/or link sets.

The invention will now be described in more detail with reference to the network configuration shown in figure 2 and the embodiment set forth figures 3a-d. Of course, the embodiment is merely explanatory and the present invention is applicable to other embodiments. For illustrative purposes figure 2 shows a signaling view of a Signaling System 7 (SS7) network configuration. Of course, the signaling view 200 is used only for exemplary purposes and may be substituted by another signaling system. As shown, a bundle of connections 202, having more or less equal properties, is denoted as a signaling link set and the single connections within one signaling link set are denoted as signaling links 204. A signaling link set together with entire set of signaling links forms the signaling connection between 2 adjacent network elements 206A and 206B.

In terms of SS7, network A and network element B are SS7 signaling points, each signaling point having an address (signaling point code) which is a unique address within a given network or sub-network.

Figure 2 depicts network elements A and B as two adjacent signaling points, which are connected with a SS7 link set. The signaling link set can contain up to n signaling links. In figure 2, each link is identified by a unique value called signaling link code (SLC). Network element A can support several networks including those for national or international traffic. The regarded network is identified by a network indicator (NI), for example, the network indicator NAT0. Within this network, network element A is identified by an originating point code or otherwise a signaling point code (SPC), which is a unique signaling address of the network element A within the example network NAT0.

Network element A can have a plurality of destinations within the example network (NAT0) which are in communication with network element A for sending and receiving messages. In the

example, one destination is defined by another signaling point code or destination point code, which is the unique signaling address to transmit messages to network element B from any network element within the example network.

Network element B operates in a similar manner to network element A described above, noting that the specific parameters and objects correspond to network element B. It shall be appreciated that network element B may have additional parameters and objects than network element A.

It shall be appreciated, in the example, that the adjacent point code for the link set 202 of network element A is the signaling point code of network element B, because network element B is the corresponding adjacent network element of network element A.

In the operation of the network configuration shown in figure 2, network elements A and B are connected by a signaling link set, which contains, for example, several signaling links.

Now that a general understanding of the network configuration in figure 2 has been described, the inventive embodiment illustrated by the flow diagram in figures 3a-d will be discussed in more detail.

In a suitable interface, the operator enters the name of the applicable network and the signaling link set within this network which is to be managed. It shall be appreciated that the implementation of the novel invention is independent on how the data is obtained. Whether the data is retrieved directly from the network elements or available by means of a data base is a further aspect of the invention. Further, the command interface, which can be a known Q3 interface, can be any type of interface and the Q.751 interface protocol therefore may be any type of protocol.

To proceed, with the flow diagram 300 shown in the figures, the signaling point identifier and the signaling link set termination point identifier are input. In step 304, the method accesses the relevant data of an object representing the specified signaling point. With this object, the method reads out a parameter representative of the network indicator and a value representing a point code for the network element A. This value indicates the own signaling point code of network element A within the exemplary network.

In step 306, the method accesses information related to the link set specified by the signaling link set termination point ID. The method further reads a value representative of the adjacent point code for the link set. This value indicates the point code of network element B within the network.

According to the invention, the method automatically detects the adjacent network element which will be described according to steps 308-322. In step 308, the method accesses the data of the available network elements. In the method shown, this is done recursively for each network element. In each network element, the method accesses the data of the object representative for the respective signaling point (step 310) and reads out the value of a parameter representative of the corresponding network indicator and a value representative of the point code in step 312. In step 314, the method searches for the network with the same network indicator as the network to which the link set of network element A belongs (NAT0 in the example). It should be noted that link sets of the network elements can belong to different networks. According to step 314, the adjacent network element is detected when the network element is found to have the same point code as the adjacent point code of the link set to be managed in network element A. For example, referring back to figure 2, it is shown that the value of the point code of the adjacent network element B is 3-3-3, and the value of the adjacent point code associated with the link set originating at net-

work element A is also 3-3-3. The method of the present invention detects that the adjacent point code information for the link set of the network element A matches the point code for the network element B and determines that be network element B is adjacent to network element A as illustrated by step 316.

In the case that no adjacent network element is found, the invention examines the next signaling point of the network element in step 318 until all signaling points of the respective network element are examined. After which, the method proceeds the next network element in step 320 and executes steps 308 to 314 recursively. This process continues until the adjacent network element is detected. If a matching point code does not exist in any of the available network elements then the adjacent network element may be assigned manually by the operator, as well as any prerequisite data for operating the network element, according to step 322.

Once the adjacent network element is detected, the next step according the invention is to determine the link set of the detected adjacent network element to be managed. To that in, the method in step 324 examines the link sets for the adjacent network element and, in step 326, reads out a value representing the adjacent point code for the examined link set. According to step 328, the method searches for a link set with a value of the adjacent point code that is equal to the point code of the network element A, of course within the detected network.

The invention continues to access link sets according to step 330 until the correct link set is found. Of course, the invention is not limited to using a recursive method for this or other steps for detecting network element information, but may be, for example, a known procedure such as a get-access method with an appropriate filter. If it is determined that no matching link set exists, the method according to step 332

creates the link set in the adjacent network element, as will be explained below with reference to steps 334 through 342.

In the instance that no link set exists for the adjacent network element, as already explained, the invention creates the link set by entering values of the link set automatically. This maybe accomplished by automatically searching the next free link set identifier, by utilizing a procedure for automatic instance naming or by allowing the operator to select a value, for example. The invention creates the link set for the adjacent network element by transposing the relevant data obtained from the operator input and/or from any of the data bases of the network or the network elements.

Now that the adjacent network element has been detected and the correct link set of the adjacent network element has been determined, the invention provides the ability to manage the signaling connection. As will be described in more detail, the invention manages the signaling connection in various ways, including creation, deletion, modification and activation (which may include status changes), of links and/or link sets.

The invention, for example, manages the signaling connection by creating links for a particular link set of the adjacent network element as will be further described according to steps 334 to 342. At step 334, each link of the link set of the network element A is addressed. According to step 336, the attribute representing the signaling link code of the link is read and stored. It is determined in step 338 whether the link, denoted by a signaling link code, which is to be created in accordance with the data for network element A, already exists for the adjacent network element. If the link already exists in the adjacent network element link set, then the invention advances to step 342. If, however, link needs to be created, the method creates the link in the adjacent network element by using consistent data as for the corre-

sponding link in network element A according to step 340. In one aspect, the link is created by transposing the attribute values for the corresponding link in network element A. The process continues until all links are so configured according to step 342. In this manner, the method enters the values for the remaining link attributes by using the same attribute values as determined in the corresponding links of network element A.

In one aspect of the invention it maybe desirable to provide by the invention for operator control over any of the transposed attribute values. Of course, the invention automatically allocates the attribute values, however, it may be useful in some instances to allow the operator to manually modify the signaling connection.

As already mentioned, the management of the signaling connection further includes deletion of links and link sets. Similar to that already described for creation of links and/or link sets, the invention deletes a link or link set of, for example, an adjacent network element commensurate with a deletion of a corresponding link and/or link set in the network element A. This is done according to the invention, by automatically calculating the commands for the deletion of the link and/or link set. This may be accomplished, for example, according to the already described method for creating a link and/or link set by transposing the corresponding attribute values of the network element A.

Similarly, when link sets and/or links are to be modified, the invention performs the identical modification in the adjacent network element. To explain, when the operator performs a modification in a link and/or link set at the network element A of the signaling connection, the method automatically calculates the commands for the commensurate modification of the corresponding link and/or link set in the adjacent network element. As before, the required adjacency in-

formation is determined in the same manner as already described. Again, the novel invention may comprise transposing the modifications from network element A, or a corresponding command history, to an adjacent network element.

Further, the invention activates or deactivates a link and/or link set corresponding to the activation (deactivation) of a corresponding link and/or link set in the network element A. For example, when the operator performs activation (deactivation) at one end of the signaling connection, the invention automatically calculates the commands for the activation (deactivation) of the link and/or link set of the adjacent network element. This may also be done according the previously-described steps for transposing the attribute values of the network element A.

The present invention is not limited to the specific management methods herein described, but may, for example, comprise any management of the signaling connection, in that it allows for other alterations performed by an operator at one end of a signaling connection to be automatically performed correspondingly at the other end of the signaling connection.

The present invention is also applicable to a system or apparatus as shown in figure 4. In the figure a network 400 maybe comprised of one or more sub-networks, such as shown network 0 (N0) and network x (N_x). In the sub-network N0, there is provided a network element A 402 which may be comprised of an application program interface (API) 402a and a switching system 402b. For purposes of example, there is provided an adjacent network element B (NE B) which includes corresponding application program interface (API) 404a and a switching system 404b. The network element A 402 is connected through a signaling connection to network element B 404 by a signaling link set 406. The signaling link set 406 maybe comprised of individual links L0...L2, which may be better understood with reference to the figure 2. For reasons of simplicity, bearer

connections, which may be applied to the present invention, are not shown.

According to the invention, there is provided a network management station 408 which may comprise a suitable operator interface 408a and a control module 408b. The network management system 408 provides operator control of the network elements by means of a connection to an application program interface (API) of any of the network elements. In operation, the operator (not shown) interacts with the operator interface 408 which, in turn, directs the control module to cause corresponding command signal(s) to control a given network element in accordance with the operator input. According to the invention, the operator is assisted by a control program residing in, for example, the control module 408b which automatically creates the commands for controlling the network elements. In the invention, the control program may control the control module 408b in accordance with one or more of the steps already described including, for example, transposing attributes corresponding to the network element A for the second network element B such that the corresponding signaling connection for the network element B is commensurate to that of network element A.

It shall be understood that the network 400 may comprise one or more sub-networks, as already described. For example, in a sub-network Nx, a link set LS1 may exist that connects network element B 404 to other network elements in the sub-network Nx. In the figure, the link set may be comprised of respective links f410a-n. According to the invention, the correct link set connecting network element A to the adjacent network element B 406 is detected, as opposed to detecting the link set in the sub-network Nx, for example. In this manner, the invention correctly identifies the adjacent network element for the automatic management of the signaling connection.

Managing Bearer Connections (Figs. 5 through 8)

A first general embodiment of the invention will now be described wherein the managed connection objects are signaling connections. Figure 5 shows in general form the flow diagram 500 of the first general embodiment of the present invention. In step 502, an operator input is made to a first network element, which is denoted by a network element A. In a preferred aspect of the invention, the operator input includes a designator of a trunk group to be managed, the designator unambiguously identifying the desired trunk group for network element A. With the operator input, the invention extracts the network or sub-network name, identified by, for example, a network indicator. In addition, the invention may extract an identifier indicating the address of a network element adjacent to network element A. This address indicates the targeted network element that is to be managed in commensuration with the data representative of the bearer connection for network element A.

In steps 504 and 506, the invention first detects, based on the operator input, an origination point code OPC of the first network element A that is associated with the desired trunk group. This may, for example, be accomplished by accessing data of all available route set destinations in network element A and matching the route set destinations and associated network indicators to the information (address of adjacent network element and network indicator) obtained from the operator input. From a matching route set destination object the origination point code is then extracted.

In step 508, the invention detects the adjacent network element. This may, for example, be accomplished by accessing data of available network elements and, in each network element, determining the network indicator and the own point code for the respective network element. In steps 510 and 512, the invention may detect elements belonging to the same

network or sub-network and, upon detecting network elements within the same network or sub-network, continues in steps 514 and 516. Among the detected network elements in the same network or sub-network, the method then detects the adjacent network element by matching information, such as, the adjacent point code detected in step 502.

The invention now detects in steps 518 and 520 the trunk group to be managed, e.g., in the adjacent network element. More specifically, and according one possible aspect of invention, the trunk groups of the detected network element are searched for the trunk group to which network element A is the adjacent network element.

After determining the correct network or sub-network and, within that, the adjacent network element, and for the adjacent network element the appropriate trunk group, the invention now has all the prerequisites to manage the bearer connection (box 522). Part of managing bearer connection may, for instance, be creation of an appropriate trunk group if no such trunk group was identified (steps 524 and 526). In more detail, the invention creates the trunk group for the adjacent network element to be commensurate with the attributes from the trunk group of the network element A. The step of managing may further comprise steps 528 to 532, in general, for detecting an object to be managed and managing the object, such as, creating trunk groups and/or trunks, deleting, modifying, activating and/or changing the status of trunks and/or trunk groups.

The invention will now be described in more detail with reference to the network configuration shown in figure 6 and the embodiment set forth figures 7 a-d. Of course, the embodiment is merely explanatory and the present invention is applicable to other embodiments. For illustrative purposes figure 6 shows a trunking view 600 of an example network configuration. As shown, a bundle of connections 602, having more or

less equal properties, is denoted as a trunk group and the single connections within one trunk group are denoted as trunks or circuits 604. A trunk group together with its entire set of trunks or circuits forms the bearer connection between two adjacent network elements 606A and 606B.

Network element A and network element B are TDM switches and also, in terms of SS7, SS7 signaling points, each signaling point having an address (signaling point code) which is a unique address within a given network or sub-network.

Figure 6 depicts network elements A and B as two adjacent signaling points, which are connected with a TDM trunk group. The TDM trunk group can contain up to n TDM trunks. In figure 6, each trunk is identified by a unique value called circuit identification code (CIC). Network element A can support several networks including those for national or international traffic. The regarded network is identified by a network indicator NI, for example, the network indicator NAT0. Within this network, network element A is identified by an originating point code or otherwise a signaling point code SPC, which is a unique address of the network element A within the example network NAT0.

Network element A can have a plurality of destinations within the example network NAT0 which are in communication with network element A for sending and receiving messages. In the example, one destination is defined by another signaling point code or destination point code, which is the unique address to transmit information to network element B from any network element within the example network.

Network element B operates in a similar manner to network element A described above, noting that the specific parameters and objects correspond to network element B. It shall be appreciated that network element B may have additional parameters and objects than network element A.

It shall be appreciated, in the example, that the adjacent point code for the trunk group 602 of network element A is the signaling point code of network element B, because network element B is the corresponding adjacent network element of network element A.

In the operation of the network configuration shown in figure 6, network elements A and B are connected by a TDM trunk group, which contains, for example, several trunks.

Now that a general understanding of the network configuration in figure 6 has been described, the inventive embodiment illustrated by the flow diagram in figures 7 a-d will be discussed in more detail.

In a suitable interface, the operator enters the name of the TDM trunk group within this network which is to be managed. It shall be appreciated that the implementation of the novel invention is independent on how the data is obtained. Whether the data is retrieved directly from the network elements or any associated management computer or available by means of a data base is a further aspect of the invention. Further, the command interface, which can be a known Q3 interface, can be any type of interface and the Q.751 interface protocol therefore may be any type of protocol.

To proceed, with the flow diagram 700 shown in the figures, the name of the desired TDM trunk group is input. In step 704, the method accesses the relevant data of an object representing the specified trunk group. With this object, the method reads out a parameter representative of the network indicator and a value representing a point code for an adjacent network element to network element A. This value indicates the destination point code of network element B within the exemplary network.

In steps 706-716, the method determines the own signaling point code or origination point code OPC of network element A associated with the desired trunk group as this information cannot be derived from the input trunk group identifier directly. In particular, the method scans all route sets (step 706), extracts from each route set a network indicator and a route set DPC (step 708) and tries to match that information to the network indicator and the adjacent point code information obtained from the targeted trunk group (step 710). If the information does not match, the method proceeds with the next available route set (step 712) and repeats steps 708 and 710. If no match was found and no further route set exists, an exception handling step 714 is entered which may , for example, comprise the creation of a route set in network element A. If a match is found, then the appropriate MTP signaling point of network element A is determined by accessing a parameter of the route set which matches the aforementioned criteria.

In step 718, the method accesses information related to the own point code specified by the MTP signaling point object. The method further reads a value representative of the own point code for the trunk group. This value indicates the point code of network element A within the network.

According to the invention, the method automatically detects the adjacent network element which will be described according to steps 720-732. In step 720, the method accesses the data of the available network elements. In the method shown, this is done recursively for each network element. In each network element, the method accesses the data of the object representative for the respective switch (step 722) and reads out the value of a parameter representative of the corresponding network indicator and a value representative of the point code in step 724. In step 726, the method searches for the network with the same network indicator as the network to which the trunk group of network element A belongs (NAT0 in

the example). It should be noted that trunk groups of the network elements can belong to different networks. According to step 726, the adjacent network element is detected when the network element is found to have the same point code as the adjacent point code of the trunk group to be managed in network element A. For example, referring back to figure 6, it is shown that the value of the point code of the adjacent network element B is 3-3-3, and the value of the adjacent point code associated with the trunk group originating at network element A is also 3-3-3. The method of the present invention detects that the adjacent point code information for the trunk group of the network element A matches the point code for the network element B and determines that be network element B is adjacent to network element A as illustrated by step 734.

In the case that no adjacent network element is found, the invention examines the next switch of the network element in step 728 until all signaling points of the respective network element are examined. After which, the method proceeds the next network element in step 730 and executes steps 720 to 726 recursively. This process continues until the adjacent network element is detected. If a matching point code does not exist in any of the available network elements then the adjacent network element may be assigned manually by the operator, as well as any prerequisite data for operating the network element, according to step 732.

Once the adjacent network element is detected, the next step according the invention is to determine the trunk group of the detected adjacent network element to be managed. To that, the method in step 736 examines the trunk groups for the adjacent network element and, in step 738, reads out a value representing the adjacent point code for the examined trunk group. The method further accesses parameters representing the network indicator and the trunk group name of the examined trunk group. According to step 740, the method searches

for a trunk group with a value of the adjacent point code that is equal to the point code of the network element A, of course within the detected network.

The invention continues to access trunk groups according to step 742 until the correct trunk group is found. Of course, the invention is not limited to using a recursive method for this or other steps for detecting network element information, but may be, for example, a known procedure such as a get-access method with an appropriate filter. If it is determined that no matching trunk group exists, the method according to step 744 creates the trunk group in the adjacent network element, as will be explained below.

In the instance that no trunk group exists for the adjacent network element, as already explained, the invention creates the trunk group by entering values of the trunk group automatically. This may be accomplished by automatically searching the next free trunk group identifier, by utilizing a procedure for automatic instance naming or by allowing the operator to select a value, for example. The invention creates the trunk group for the adjacent network element by transposing the relevant data obtained from the operator input and/or from any of the data bases of the network or the network elements.

Now that the adjacent network element has been detected and the correct trunk group of the adjacent network element has been determined, the invention provides the ability to manage the bearer connection. As will be described in more detail, the invention manages the bearer connection in various ways, including creation, deletion, modification and activation (which may include status changes), of trunks and/or trunk groups.

The invention, for example, manages the bearer connection by creating trunks for a particular trunk group of the adjacent

network element as will be further described according to steps 746 to 754. At step 746, each trunk of the trunk group of the network element A is addressed. According to step 748, the attribute representing the circuit identification code CIC of the trunk is read and stored. It is determined in step 750 whether the trunk, denoted by a circuit identification code, which is to be created in accordance with the data for network element A, already exists for the adjacent network element. If the trunk already exists in the adjacent network element trunk group, then the invention advances to step 754. If, however, the trunk needs to be created, the method creates the trunk in the adjacent network element by using consistent data as for the corresponding trunk in network element A according to step 752. In one aspect, the trunk or circuit is created by transposing the attribute values for the corresponding trunk in network element A. The process continues until all trunks are so configured according to step 754. In this manner, the method enters the values for the remaining trunk attributes by using the same attribute values as determined in the corresponding trunks of network element A.

In one aspect of the invention it may be desirable to provide for operator control over any of the transposed attribute values by the invention. Of course, the invention automatically allocates the attribute values, however, it may be useful in some instances to allow the operator to manually modify the bearer connection.

As already mentioned, the management of the bearer connection further includes deletion of trunks and trunk groups. Similar to that already described for creation of trunks and/or trunk groups, the invention deletes a trunk or trunk group of, for example, an adjacent network element commensurate with a deletion of a corresponding trunk and/or trunk group in the network element A. This is done according to the invention, by automatically calculating the commands for the deletion of

the trunk and/or trunk group. This may be accomplished, for example, according to the already described method for creating a trunk and/or trunk group by transposing the corresponding attribute values of the network element A.

Similarly, when trunk groups and/or trunks are to be modified, the invention performs the identical modification in the adjacent network element. To explain, when the operator performs a modification in a trunk and/or trunk group at the network element A of the bearer connection, the method automatically calculates the commands for the commensurate modification of the corresponding trunk and/or trunk group in the adjacent network element. As before, the required adjacency information is determined in the same manner as already described. Again, the novel invention may comprise transposing the modifications from network element A, or a corresponding command history, to an adjacent network element.

Further, the invention activates or deactivates a trunk and/or trunk group corresponding to the activation (deactivation) of a corresponding trunk and/or trunk group in the network element A. For example, when the operator performs activation (deactivation) at one end of the bearer connection, the invention automatically calculates the commands for the activation (deactivation) of the trunk and/or trunk group of the adjacent network element. This may also be done according the previously-described steps for transposing the attribute values of the network element A.

The present invention is not limited to the specific management methods herein described, but may, for example, comprise any management of the bearer connection, in that it allows for other alterations performed by an operator at one end of a bearer connection to be automatically performed correspondingly at the other end of the bearer connection.

The present invention is also applicable to a system or apparatus as shown in figure 8. In the figure a network 800 may be comprised of one or more sub-networks, such as shown network 0 (N0) and network x (N_x). In the sub-network N0, there is provided a network element A 802 which may be comprised of an application program interface (API) 802a and a switching system 802b. For purposes of example, there is provided an adjacent network element B which includes a corresponding application program interface (API) 804a and a switching system 804b. The network element A 802 is connected through a bearer connection to network element B 804 by a TDM trunk group 806. The trunk group 806 may be comprised of individual trunks CIC0...CIC2, which may be better understood with reference to the figure 6. For reasons of simplicity, signaling connections, which may be applied to the present invention, are not shown.

According to the invention, there is provided a network management station 808 which may comprise a suitable operator interface 808a and a control module 808b. The network management system 808 provides operator control of the network elements by means of a connection to an application program interface (API) of any of the network elements. In operation, the operator (not shown) interacts with the operator interface 808 which, in turn, directs the control module to cause corresponding command signal(s) to control a given network element in accordance with the operator input. According to the invention, the operator is assisted by a control program residing in, for example, the control module 808b which automatically creates the commands for controlling the network elements. In the invention, the control program may control the control module 808b in accordance with one or more of the steps already described including, for example, transposing attributes corresponding to the network element A for the second network element B such that the corresponding bearer connection for the network element B is commensurate to that of network element A.

It shall be understood that the network 800 may comprise one or more sub-networks, as already described. For example, in a sub-network Nx, a trunk group TG1 may exist that connects network element B 804 to other network elements in the sub-network Nx. In the figure, the trunk group may be comprised of respective trunks 810a-n. According to the invention, the correct trunk group connecting network element A to the adjacent network element B 806 is detected, as opposed to detecting the trunk group in the sub-network Nx, for example. In this manner, the invention correctly identifies the adjacent network element for the automatic management of the bearer connection.

While the various aspects of the invention have been described with respect to certain standards or conventions, it shall be appreciated that the scope of the several claims or not limited thereto, but may, for example, include any standard or protocol not relating to a standard including the ITU Q.751 standard. Therefore, any references to specific objects or attribute names in the specification or figures relating to any standard are exemplary only and the invention certainly covers any embodiments.